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FORECAST OF 1967 PINK SALMON RUNS IN SOUTHEASTERN ALASKA

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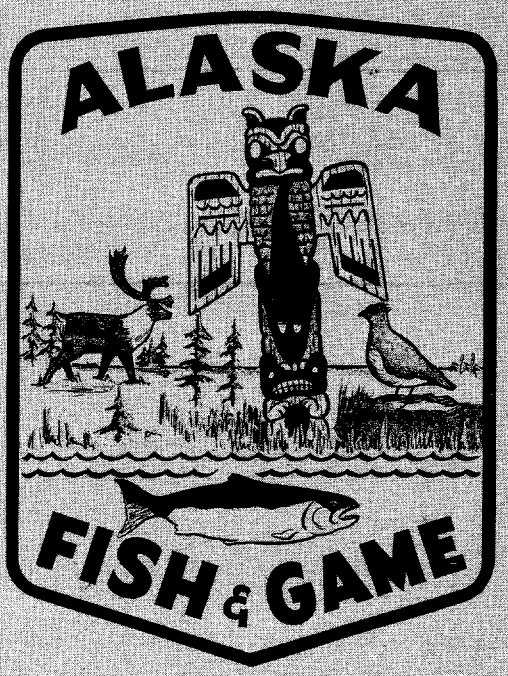

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INTRODUCTION

In 1966 the third series of pre-emergent pink salmon fry samples was taken from the spawning streams of Southeastern Alaska. Previous sampling on a "production basis" was done in 1964 and 1965 and some pilot work was performed in 1963.

The primary objective of this work is the development of a method for predicting a year in advance the abundance of pink salmon adults returning to Southeastern Alaska. Pre-emergent fry data has been used satisfactorily as a basis for prediction in Prince William Sound for several years (Roys, 1966). The thought behind these studies rests on the assumption that a consistent relationship exists between the abundance of pink salmon fry within the spawning gravels just prior to emergence, and the abundance of the returning run produced by them.

In Southeastern Alaska sufficient pre-emergent fry and return data has not yet been collected by which this relationship can be demonstrated. Attempts have been made to match fry densities found in Southeastern with similar values found in Prince William Sound, the expectation being that similar fry densities would produce similar adult returns. This was recognized as a chancy business since Southeastern Alaska is about four times the size of Prince William Sound and of much greater complexity.

METHODS

Pre-emergent fry sampling methods are described in the reports of Noerenberg (1961, 1963) and Hoffman (1965, 1966). Some differences were

incorporated into the 1966 sampling in Southeastern Alaska, not so much in techniques as in gear and areas sampled. Experience had dictated that additional upstream areas required sampling before our sample could be considered representative. The utilization of lighter gear mounted on pack boards plus the increased use of helicopters has permitted additional upstream sections to be sampled (Table 1). Downstream areas sampled are due for revision since it is suspected that many of them extend too far into the intertidal zone. Such revision may require a change in analytical approach to maintain data comparability.

A further difference in method is concerned with data analysis. Southeastern Alaska appears to consist of two biologically separate halves. Tagging experiments performed in both northern and southern Southeastern have consistently demonstrated that little mixing of stocks occurs between these areas. The dividing line between these halves is the series of islands Mitkof, Kupreanof, and Kuiu (Figure 1). All waters north and westerly of this complex are considered the northern area; all other state waters, the southern area. Data will be analyzed on this basis.

1964 and 1965 Sampling

The pre-emergent fry sampling and the resulting forecasts during these initial years are covered in the reports of Hoffman (loc cit). In general, the 1965 forecast (1964 sampling) predicted fair to strong pink salmon runs to various geographical areas where good parent escapement was matched by good fry survival. Where either factor appeared weak, lesser returns were predicted. Since no background data existed, the 1965 forecast lacked accuracy in many respects.

The forecast for 1966 (1965 sampling) was presented differently from that of 1965. All of Southeastern Alaska was treated as a single geographical unit and a return of 10-11 million pink salmon was forecast for the entire area. Events proved this estimate to be extremely low. In excess of 20 million pinks were taken in the fishery with an additional 8 million escaping into the spawning streams of Southeastern Alaska.

1966 Sampling

As shown in Table 1, pre-emergent fry sampling in 1966 was expanded in both upstream and downstream locations. In total points dug the increase amounted to 697 points - nearly 26%. One rather serious problem attended this increase. The period during which pre-emergent pink salmon fry sampling may be done is relatively short. There is approximately a two-month period between ice breakup in the streams and outmigration of the young pink salmon. All field work must be done in this period and if early spring storms inhibit

Table 1. Pink salmon pre-emergent sampling effort - Southeastern Alaska 1964, 1965, 1966.

Year	Number Streams Sampled By ADF&G	By Others	Points Dug by all Agencies Downstream	Upstream	Total
1964	46	5 *	2,141 **	546	2,686
1965	45	5 *	1,940	729	2,669
1966	63	0	2,340	1,026	3,366

* Harris R., Twelvemile Cr., by FRI: Lovers Cove, Sashin Cr., Traitors Cove, by BCF

** 140 points in Disappearance Cr. not included; a chum salmon stream.

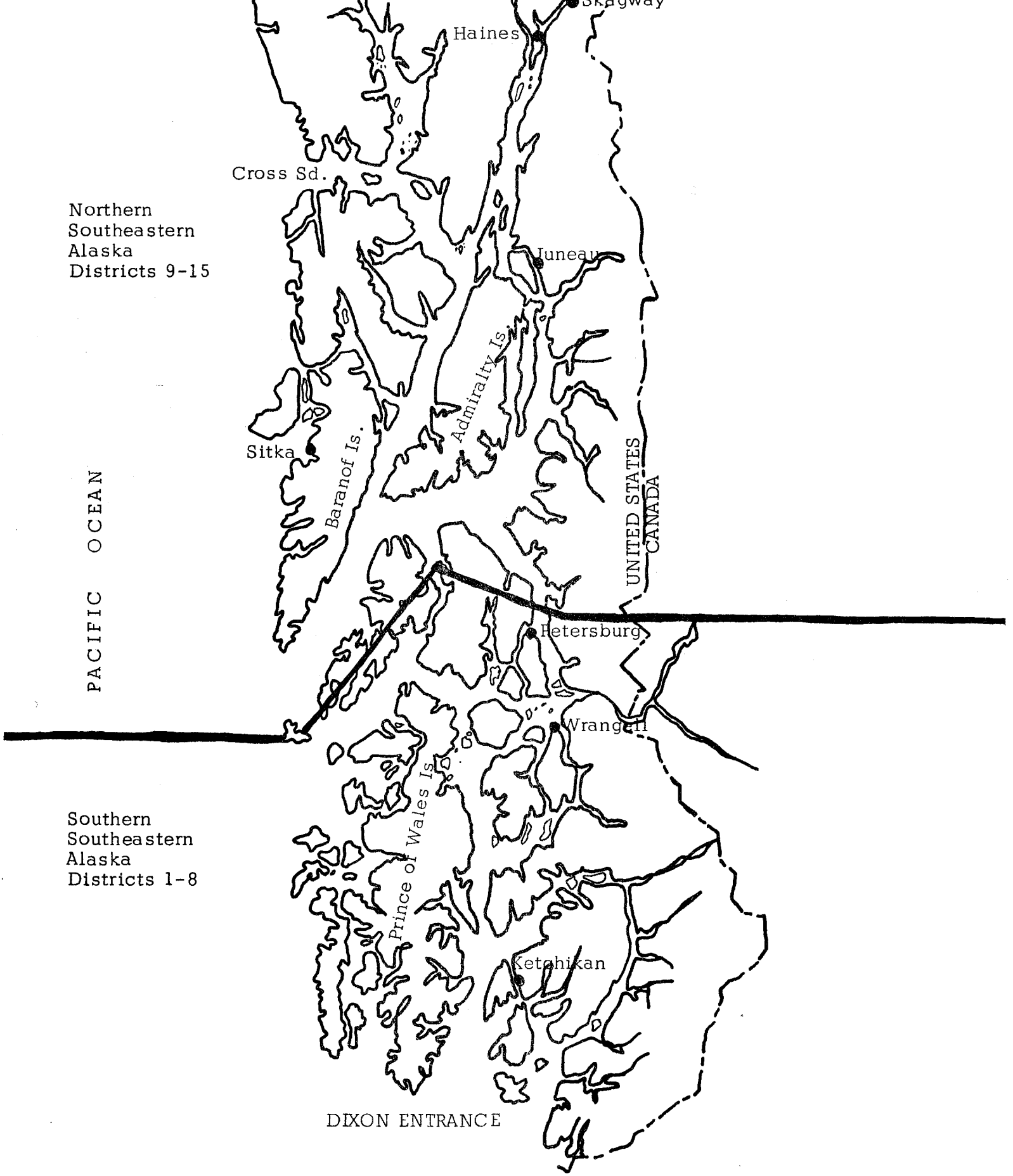


Figure 1. Map of Southeast Alaska showing division between northern and Southern sections.

field activities, sampling may occur in streams in which a portion of the young pinks have emerged from the gravel. To some degree this occurred in 1966, and is partially taken into account in the forecast for 1967.

Data Analysis

Due to the limited nature and amount of data currently available for predicting pink salmon returns to Southeastern Alaska, a complete statistical analysis is neither possible nor justified. Confidence intervals, calculated spawner-recruit curves, correlation coefficients, and similar mathematical manipulations require data that does not as yet exist. At this writing pre-emergent sampling on a production basis has been conducted only for the three-year period 1964, 1965 and 1966 with adult returns available for the two years, 1965 and 1966. Therefore, any statements or forecast estimates made should be considered as qualified by our limited data, even when this is not specifically stated.

It is possible, however, to produce from existing information a general estimate of the 1967 pink salmon run that (hopefully) might be sharpened somewhat by our limited pre-emergent data. Existing information includes the annual escapement indices as obtained by Southeastern Alaska management biologists and the pink salmon catch taken in the commercial fishery. Both these items are shown in Table 2 individually and are then summed to show total run. The item labeled "Escapement Index" in Table 2 is an index derived from the sum of the peak counts found in surveyed streams and does not cover actual escapement.

Table 2. Pink salmon runs 1960-1966 (thousands of fish)

Year	1960	1961	1962	1963	1964	1965	1966	Average Odd Yrs.	Average Even Yrs.
Southern Southeastern									
Escapement Index	1,927	2,355	4,235	3,915	4,745	2,944	5,402	3,071	4,077
Catch	1,540	3,875	11,007	5,146	11,259	5,709	15,622	4,910	9,857
Total Run	3,467	6,230	15,242	9,061	16,004	8,653	21,024	7,981	13,934
Northern Southeastern									
Escapement Index	1,241	2,562	1,924	4,027	2,111	2,517	2,787	3,035	2,017
Catch	1,429	8,698	560	13,920	7,246	5,098	4,752	9,239	3,497
Total Run	2,670	11,260	2,484	17,947	9,357	7,615	7,539	12,274	5,514

Escapement-Return Estimate

The use of escapement-return data in forecasting pink salmon runs is based on the assumption that a correlation between escapement and return exists, i.e., that a big run means a big return two years later. It is well documented that small runs of pink salmon can also bring large returns and that large runs sometimes produce small returns, but in general these are exceptions rather than rules. Escapement and return data, while far from exact, is not without some value in estimating size of future runs.

It is shown in Table 2 that since 1960 the odd-year returns to the southern half of Southeastern have ranged from 6.2 to 9.1 million pinks with an average of 8.0. In the northern half, odd-year returns have varied from 7.6 to 17.9 million pinks, an average of 12.3. These data are plotted in Figure 2 against the escapement that produced them. The same data are plotted for the even years, but since we are attempting to forecast an odd year return (1967), the odd year data are of primary concern.

From Figure 2 it is apparent that the 1965 escapement index values for the southern (2.9 million) and northern (2.5 million) halves of Southeastern Alaska indicate adult returns to these areas of approximately 8.1 and 9.7 million pinks respectively in 1967. As compared to the parent runs, these figures represent a 0.6 million decrease in southern Southeastern and a 2.1 million increase in the northern half. Why the lesser escapement to northern Southeastern should produce the larger return opens an area of speculation we will not venture into with our present marginal data.

Pre-emergent Values

The use of the above escapement-return data in estimating the 1967 pink salmon run is accompanied with full awareness that this approach smooths the peaks and valleys of the abundance range. Our limited pre-emergent fry values may, however, replace some of these points.

With one exception the pre-emergent fry figures obtained can be accepted as generally in accord with the run actually returning the following year--that is, when the fry value goes down the returning run is less. The exception is the 16.0 fry per 0.1 sq. meter figure for southern Southeastern in 1965. Figures 2A and 2B show the total pink salmon runs to southern and northern Southeastern respectively for 1960-1966 and also show the pre-emergent values for the years these data exist; 1964, 1965 and 1966. The 16.0 fry value for southern Southeastern in 1965 is some 13% lower than the 19.6 figure for 1964, but it produced a run nearly 2-1/2 times that produced by the higher fry value of the previous year.

There is no clear answer to this anomaly as yet. It is not even clear

Figure 2. Pink salmon escapement-return relationship.

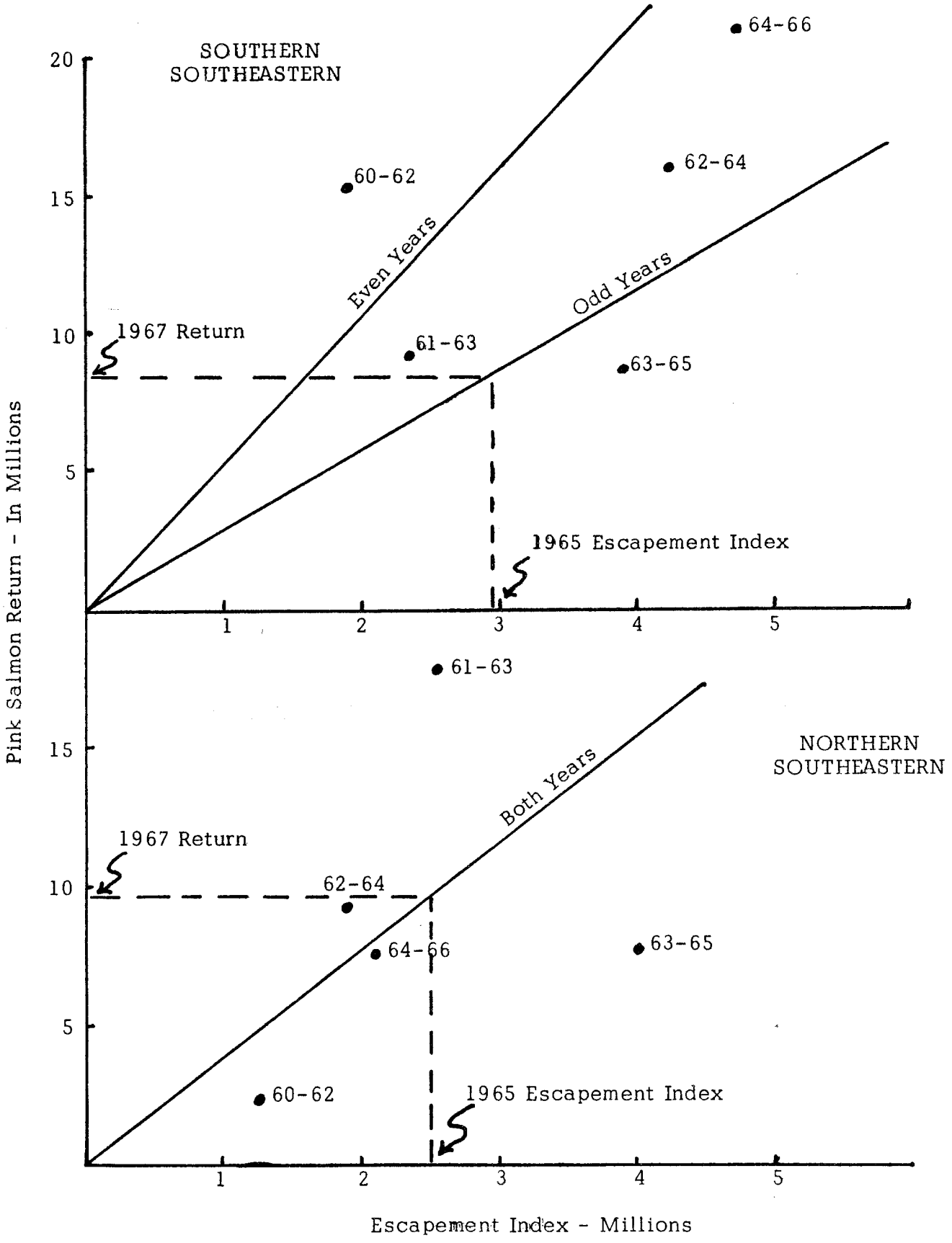
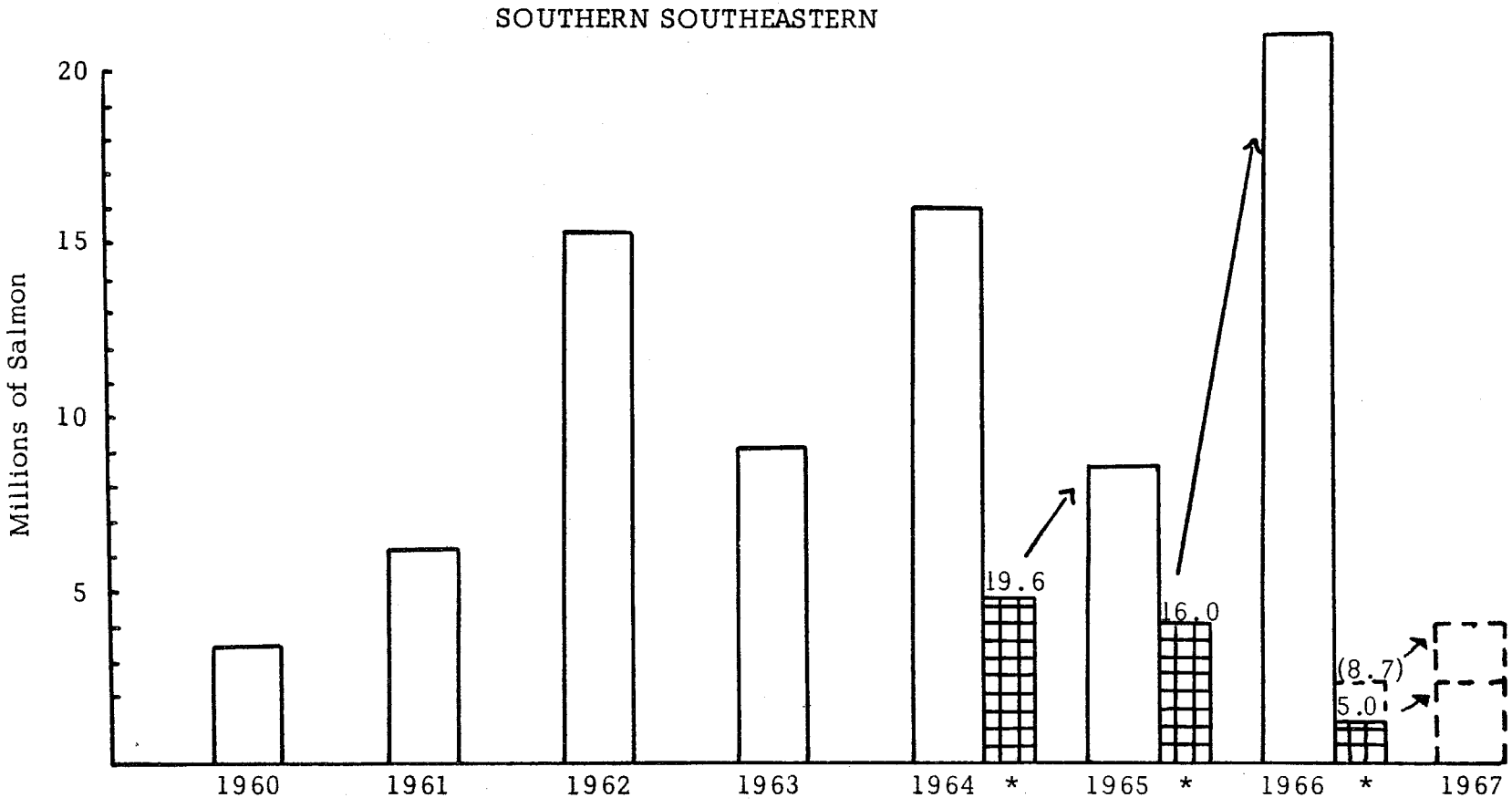
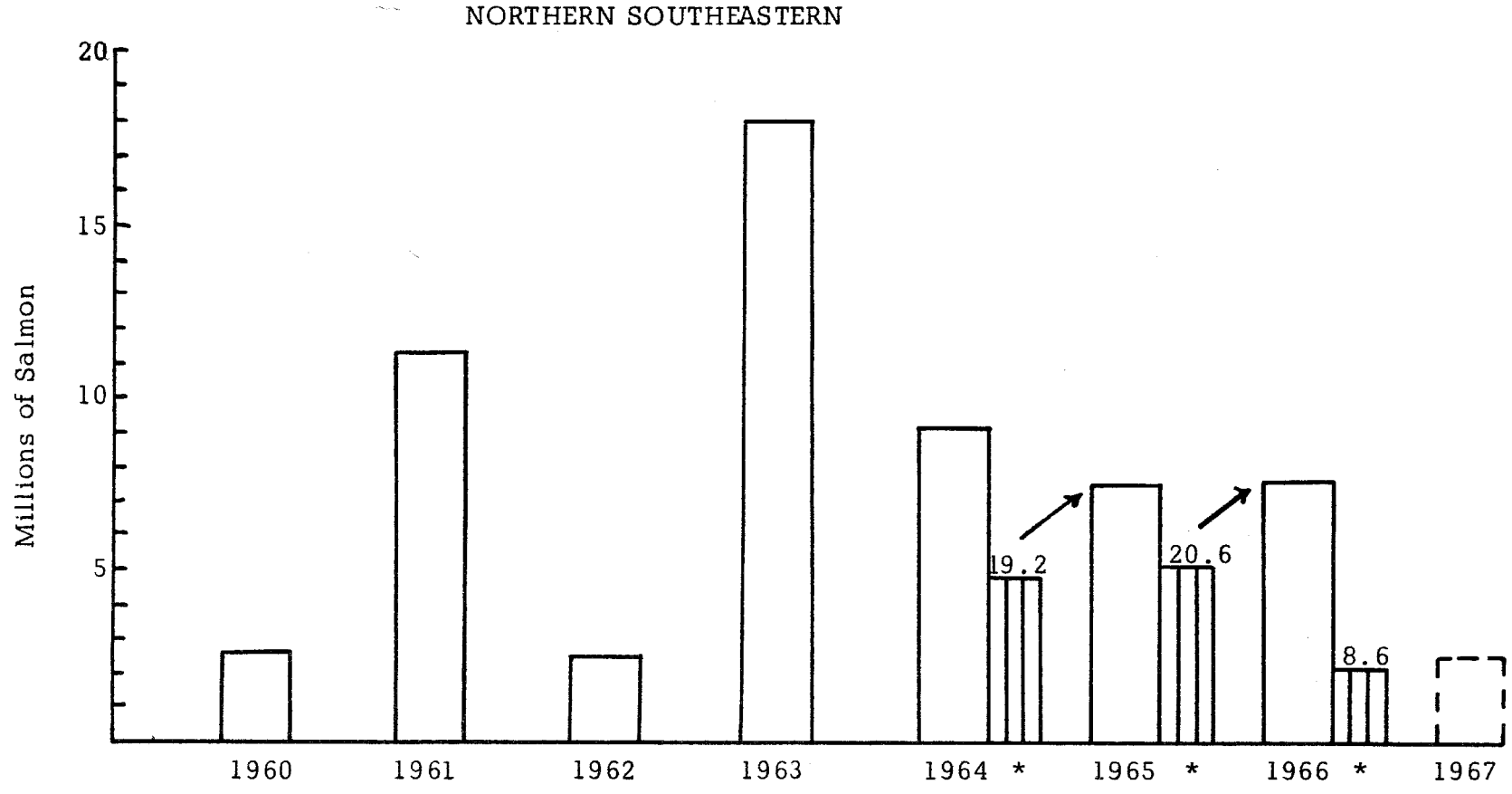


Figure 2A. Showing (1) the total run (catch plus escapement) in southern Southeastern Alaska, 1960-1966, (2) the pre-emergent indices for 1964, 1965, 1966, and (3) indicating the relationship between each index and the returning run the following year.



* Fry per 0.1 square meter in 1964, and 1965 produced the runs indicated by arrows in 1965 and 1966. Fry values shown in 1966 (5.0-8.7) result in the pre-emergent forecasts indicated by dashed lines.

Figure 2B. Showing (1) the total run (catch plus escapement) in northern Southeast Alaska 1960-1966, (2) the pre-emergent indices for 1964, 1965, and 1966, and (3) indicating the relationship between each index and the returning run the following year.



* Fry per 0.1 square meter in 1964 and 1965 produced the runs indicated by arrows in 1965 and 1966. The fry value shown in 1966 (8.6) result in the minimum pre-emergent forecast indicated by dashed lines.

an anomaly exists. Various possibilities suggest themselves: (1) sampling error(2) variable post-sampling mortality (3) different spawning distribution and hence differing rates of survival in odd and even years (4) mass straying under certain conditions not yet recognized, etc., etc. All or part of these factors (or others) may operate and in certain combinations affect the constancy of whatever correlation exists between pre-emergent fry and returning adults.

Table 3 shows the result of all pre-emergent fry sampling since 1964 on a district basis and also a total fry value for both the southern and northern sections of Southeastern. The pre-emergent fry indices were obtained by averaging the fry values for all streams sampled within a district then weighting this average by the average (1960-1966) escapements to that particular district. This weighting procedure was used in an attempt to weight district fry indices by the salmon producing importance of individual districts. The districts referred to are commercial fishing districts as set up by the Alaska Department of Fish and Game. The streams of two districts (No.'s 4 and 15) have never been sampled for pre-emergent fry since neither area produces pink salmon in important quantities.

Pre-emergent Forecast for Southern Southeastern

To estimate the 1967 pink salmon return from pre-emergent fry sampling, past sampling values must be compared to the corresponding adult return. The most serious restriction to this procedure lies, of course, in the limited amount of data currently available.

Omitting the small amount of pilot work performed in 1963, pre-emergent fry values were obtained in 1964 and 1965. These data concern the brood years 1963 and 1964, and the return runs of 1965 and 1966, thus providing information for one odd and one even cycle of pink salmon. Figure 3 shows the pre-emergent fry indices plotted against their corresponding returns. Linear regression equations have not been calculated for these data, but trend lines are drawn to provide a general indication of the relationship between pre-emergent values and their consequent returns.

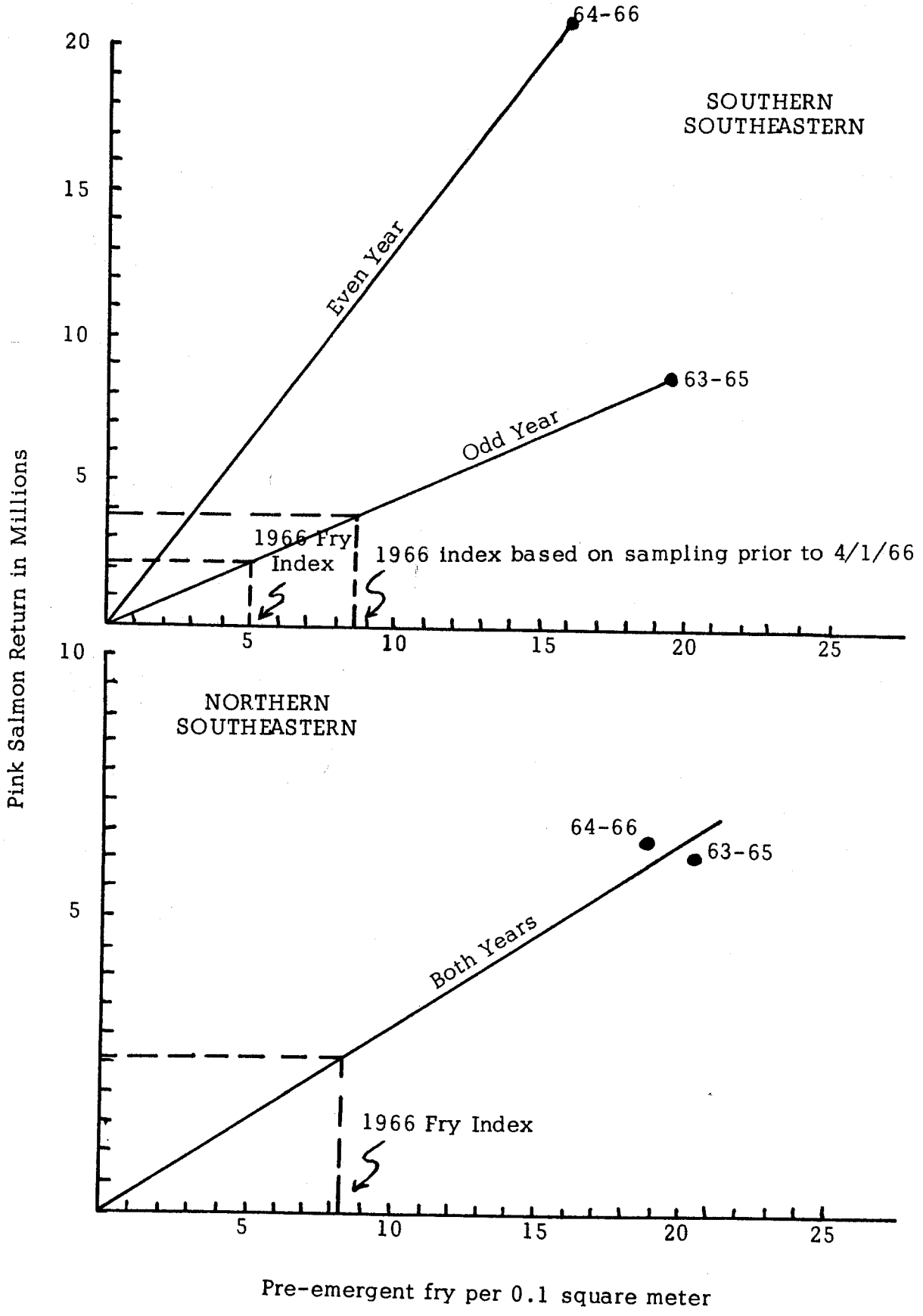
As is apparent from Figure 3, the larger fry index of 19.6 fry per 0.1 square meter from the 1964 sampling produced a return of 8.7 million pinks to the southern section in 1965. The smaller value of 16.0 fry per 0.1 square meter in 1965 resulted in a return of 21.0 million in 1966. This is the so-called "anomaly" previously mentioned. Referring back to Table 2, the even-year spawning populations apparently enjoy a higher return per spawner in southern Southeastern than do the odd-year spawners. Possible causes of cyclic dominance in pink salmon are discussed by Ricker (1962). It seems logical that data for years of dominance should be handled separately from that of other years. The possible changes in dominance from odd to even years, and vice versa, may require additional adjustments. Further informa-

Table 3. Southeastern Alaska pink salmon pre-emergent fry indices, 1964-1966. (Indices expressed in fry per 0.1 square meter)

District	1960-66 ave. escapement in thousands	Pre-emergent fry indices 1964	1965	1966	Number of streams sampled 1964	1965	1966
Southern Southeastern							
1	1,033	26.4	10.6	2.9	3	6	8
2	333	20.4	11.3	17.6	6*	3	2
3	971	23.1	27.9	6.4	7	2	8
4	14	----	----	----	0	0	0
5	349	----	7.2	1.7	0	4	3
6	427	5.4	22.8	2.4	4	3	4
7	396	12.7	7.8	2.1	5	4	3
8	123	3.0	8.8	----	1	1	0
Weighted Indices 1/	3,646	19.6	16.0	5.0	26	23	28
Northern Southeastern							
9	549	19.1	18.2	7.1	3	5	5
10	379	5.0	26.7	6.0	5	4	4
11	357	12.2	4.5	4.4	3	2	3
12	367	21.1	26.3	15.1	6**	6	5
13	308	39.5	27.0	5.1	8**	6	11
14	338	----	22.8	14.6	0	4	7
15	153	----	----	----	0	0	0
Weighted Indices 1/	2,451	19.2	20.6	8.6	25	27	35

1/ Fry indices weighted by district escapement average, 1960-1966.
* Disappearance Creek included; a chum salmon stream.
** In 1964 six additional streams were in District 12 (Peril St.); these have been shifted to District 13 to agree with a 1965 boundary change.

Figure 3. Southeastern Alaska pink salmon pre-emergent fry/adult return relationship.



tion should resolve these problems.

Some comment should be made on the remarks recorded in the field during the 1966 sampling. Of the 28 streams sampled in southern Southeastern, bottom shift was noted in 3, significant numbers of dead eggs or fry observed in 7, and 14 (half) the streams were sampled after April 1, leading to some concern that sampling may have been too late.

The first two items would not affect the validity of the counts obtained through pre-emergent fry sampling, but the third could easily have had a lowering effect on the final fry index. For this reason we have calculated the fry index for southern Southeastern in two ways: (1) on the basis of the total 28 streams sampled, and (2) on the basis of the 14 streams sampled prior to April 1. Using the resulting two indices of 5.0 and 8.7 provides a range of 2.3 to 4.0 million pink salmon as the pre-emergent forecast for the southern half of Southeastern Alaska.

Pre-emergent Forecast for Northern Southeastern

As with the southern section, two years of pre-emergent data (one odd and one even) exist for the northern half of Southeastern Alaska. The trend of odd-year dominance in the northern area, however, was broken, and the excellent run in 1963 was not repeated in 1965 in spite of excellent escapements. With the benefit of hindsight, it can now be said the similar pre-emergent fry values of 19.2 in 1964 and 20.6 in 1965 indicated the similar return runs that actually occurred in 1965 and 1966.

Whether the odd-year dominance in northern Southeastern will reassert itself in 1967 is questionable. On the basis of 1966 pre-emergent fry sampling such an event seems unlikely since the pre-emergent index value of 8.6 fry per 0.1 square meter is the lowest obtained in the short history of the program. Some concern is also present regarding the lateness of the sampling in the northern section but it appears no stratification in time can be accomplished without sacrificing the equitable distribution of sampled streams within the producing districts. Perhaps the safest approach is to look upon our 8.6 fry index as a minimum index of fry abundance. On this basis a minimum of 2.5 million pinks can be expected to return to northern Southeastern in 1967. An odd-year pink salmon run this low has not occurrred in northern Southeastern since 1953, though even-year runs of similar magnitude are not uncommon.

Summary of Forecasts

Table 4 shows forecasts for the two halves of Southeastern Alaska based on (1) escapement-return data, and (2) pre-emergent fry data. Although our pre-emergent fry data is limited in quantity when compared to escapement-return data, the former provides information at a much later life stage than does escapement. It follows that this later value, the pre-emergent fry index,

being derived after significant natural mortalities have occurred, should result in a closer estimate of return than the earlier escapement index. We have therefore arbitrarily assigned double weight to the pre-emergent fry index.

Table 4. Southeastern Alaska Pink Salmon Forecast, 1967 (in millions)

Forecast Basis	Southern Half	Northern Half	Total
Escapement Index	8.1	9.7	17.8
Pre-emergent Index	2.3 - 4.0*	2.5	4.8 - 6.5
Weighted Forecast	4.2 - 5.4	4.9	9.1 - 10.3

* Adjusted fry index based on sampling prior to April 1.

It should be remembered that the prediction of 2.5 million pink salmon shown in Table 4 for the northern half of Southeastern is to be considered a minimum since no adjustment was possible for lateness of the sample.

Pink salmon runs as low as those forecast in Table 4 have occurred previously in Southeastern Alaska. Referring back to Table 2 it is shown that southern Southeastern experienced such a return in 1960 and that the northern half had poor runs in 1960 and 1962. Before statehood, in the 9-year period 1951-1959, catch figures only indicate that below average runs for the period returned to southern Southeastern in 1953 and 1959 and to the northern area in 6 of the 9 years tabulated (Simpson, 1960).

If there is any virtue to the pre-emergent sampling as performed in 1966 it appears we are due for another relatively poor pink salmon year in Southeastern Alaska in 1967.

LITERATURE CITED

HOFFMAN, THEODORE C. 1965. Southeastern Alaska pink salmon forecast studies pre-emergent fry program. Alaska Department of Fish and Game, Informational Leaflet No. 47.

----------. 1966. Southeastern Alaska pink salmon forecast studies pre-emergent fry program, 1965. Alaska Department of Fish and Game, Informational Leaflet No. 88.

NOERENBERG, WALLACE H. 1961. Observations on spawning and subsequent survival of fry of the 1960 salmon runs in Prince William Sound, Alaska. Alaska Department of Fish and Game, Memorandum No. 5.

----------. 1963. Salmon forecast studies on 1963 runs in Prince William Sound. Alaska Department of Fish and Game, Informational Leaflet No. 21.

RICKER, W.E. 1962. Regulation of the abundance of pink salmon population. Symposium on pink salmon. H. R. MacMillan, Lectures on Fisheries, University of British Columbia, Vancouver, B.C.

ROYS, ROBERT S. 1966. Forecast of 1966 pink and chum salmon runs in Prince William Sound. Alaska Department of Fish and Game, Informational Leaflet No. 80.

SIMPSON, ROBERT R. 1960. Alaska Commercial Salmon Catch Statistics, 1951-1959. Bureau of Commercial Fisheries, Fish and Wildlife Service Statistical Digest 50.